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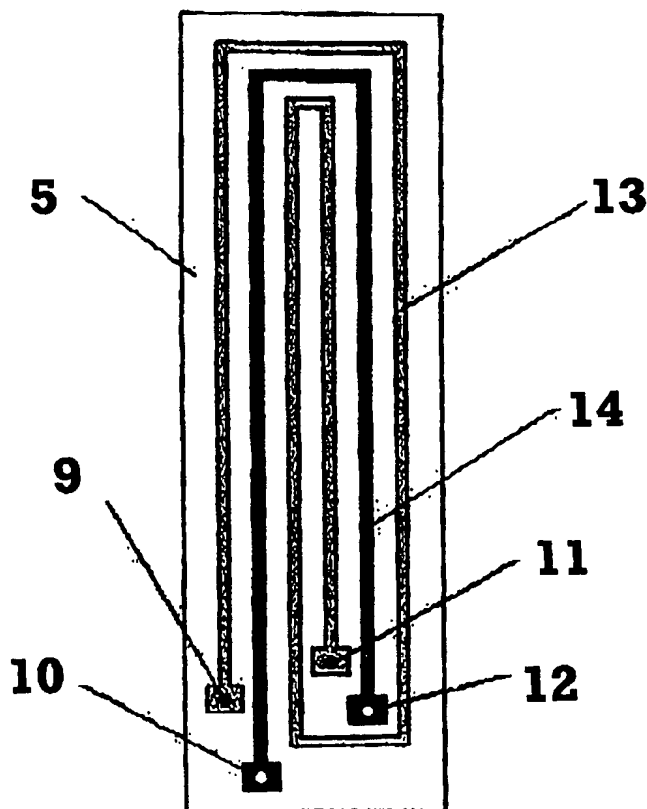
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[Continued on next page]

(54) Title: PLANAR SPEAKER WIRING LAYOUT



(57) Abstract: Trace runs for Planar Line Source Transducers (or speakers) are separated into multiple trace circuits which are electrically isolated but occupy the same area on the planar film. The separate trace runs are then driven with different electrical signals with tailored spectral content in order to achieve an overall acoustical frequency response. By having the separate trace runs occupy the same area, the line source nature of the transducer is preserved over the entire intended spectral response of the transducer and the mechanical structure is also kept simple. External spectral filtering circuits are used to pre-shape the spectral signal into each individual trace run and in most cases, the filtering components are passive and inexpensive.

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1 TITLE

2

3 Planar Speaker Wiring Layout

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5 FIELD OF INVENTION

6

7 This invention relates to transducers which convert
8 electrical energy into acoustical energy, one application
9 being planar line source loudspeakers

10

11 BACKGROUND OF THE INVENTION

12

13 Planar transducers (also referred to as speakers)
14 have a film composed of mylar, polyester, kapton, etc,
15 suspended between rows of fixed magnetic bars composed of
16 ceramic, neodymium(a rare earth), etc. Electronic
17 signals carrying the sound to be generated are sent
18 through the wires imbedded in the film. The variable
19 magnetic fields created by the thin wires interact with
20 the nearby fixed magnets to vibrate the film, thereby
21 creating sound waves. They are similar to electrostatic
22 speakers only in that thin film propagates the sound
23 waves. Electrostatics don't use magnets, but create a
24 magnetic field by reciprocating the field back and forth
25 through high voltage stators via a transformer. A planar
26 can handle much more power and produce higher sound
27 pressure levels (SPL). The best version of a planar is a
28 Line Source type. A "Line Source" version planar is
29 narrow in width and very long compared to its width.
30 This produces a cylindrical pattern, yielding enormous
31 lateral coverage and almost no directionality above or
32 below the ends of the driver. They also are very rugged
33 and present an almost purely resistive load to the
34 amplifier. Line source speakers can also handle a lot of

1 power as the relatively large area of film results in a
2 large distribution of the power. Developed many years
3 ago, they have recently become more popular with the
4 advent of high power magnets, durable thin films,
5 advanced adhesives to hold the aluminum traces to the
6 film, sturdier metals for lighter framework, and
7 tensioning techniques. No other speaker design offers
8 the low distortion, excellent coverage, even dispersion,
9 limited ceiling-floor reflections, and high SPL's as does
10 a Planar Line Source.

11

12 Higher frequency audio components are more
13 directional, and it has been discovered that in a
14 diaphragm type transducer, it is desirable to have the
15 higher frequency audio sounds emanate from a narrow and
16 long strip like zone or area of the vibrating diaphragm.
17 If the strip transducer is oriented in an upright
18 position, the higher frequency audio sounds will emanate
19 horizontally in substantially all directions resulting in
20 a more uniform distribution of the audio signal. Sound
21 attenuates only 3 dB for each doubling of distance
22 instead of 6 dB as in conventional point source speakers.
23 This provides for more consistent coverage and minimizes
24 lost acoustic power.

25

26 Lower audible frequencies on the other hand do not
27 tend to be as directional as the higher frequencies and
28 can either be handled with a planar speaker or a separate
29 more conventional point source speaker with no loss in
30 performance.

31

32 US patent number 3,919,499 (incorporated herein by
33 reference) (November 11, 1975) discloses a planar film
34 speaker composed of planar zones where each zone may have

1 a separate circuit for reproducing a different spectrum
2 of the audio signal.

3

4 US patent number 4,037,061 (incorporated herein by
5 reference) (July 19, 1977) discloses a mechanical
6 structure which permits a rapid and relatively simple
7 assembly where the tolerances are automatically obtained
8 as a result of the transducer design.

9

10 US patent number 3,919,499 (incorporated herein by
11 reference) is believed to be the closest prior art.
12 However, it differs from this invention in that the
13 different line circuits for reproducing different audio
14 spectrum are in separate structures or locations which
15 can require a larger physical structure or result in a
16 larger aperture which may diminish the speaker's "sweet
17 spot" area of audio sound reproduction.

18

19

20 SUMMARY OF THE INVENTION

21

22 The main aspect of this invention is to create
23 electrically separate line trace runs which occupy the
24 same area on the vibrating film with the intention of
25 driving the separate trace runs with different spectral
26 components of the input signal. By having the separate
27 line runs occupy the same area, the line source nature of
28 the speaker is achieved with excellent frequency
29 response.

30

31 One of the drawbacks of a planar line source speaker
32 is that the higher frequencies above 10,000 to 20,000 Hz
33 are somewhat rolled off (not as loud) in comparison to
34 the lower frequencies. Also, there is typically some

1 amplitude peaking in the mid audio range. This peaking
2 must be eliminated by a notch filter which attenuates the
3 input signal in the frequency range of the peaking. One
4 aspect of this invention is to improve the audio output
5 frequency response in a simple and economical manner
6 while preserving the line source characteristics of the
7 transducer.

8

9 A line trace circuit is a single continuous
10 conductor mechanically mounted to the vibrating film. In
11 the prior art, multiple sets of line trace circuits have
12 been used to reproduce different audio spectrums. The
13 different circuits have been physically separated. In
14 some cases, the structure of the speaker is different in
15 the areas of the different line traces complicating the
16 design and also resulting in different parts of the
17 signal spectrum emanating from separate line acoustical
18 radiation sources. For example, the spacing between the
19 vibrating film and the magnet structure may be different
20 in the two areas. Another aspect of this invention is to
21 implement separate line trace circuits but to allow the
22 circuits to be physically close so as to have similar
23 audio spatial and dispersion outputs for the different
24 frequency ranges.

25

26 It is also known that the larger the vibrating panel
27 width, the smaller will be the audio sound dispersion
28 angle. It is also an aspect of this invention to keep the
29 width of the vibrating source as narrow as possible in
30 order to better approximate a true line source with its
31 improved dispersion angle.

32

33 Other aspects of this invention will appear from the
34 following description and appended claims, reference

1 being made to the accompanying drawings forming a part of
2 this specification wherein like reference characters
3 designate corresponding parts in the several views.

4

5 **BRIEF DESCRIPTION OF THE DRAWINGS**

6

7 Figure 1 is a front plan view representation of a
8 stereo speaker system.

9

10 Figure 2 is an end sectional view of a planar
11 speaker taken along line 2-2 of figure 1.

12

13 Figure 3 is a prior art front plan view of the
14 circuit run trace of a planar speaker.

15

16 Figure 4 is a front plan view of the trace runs of
17 the preferred embodiment.

18

19 Figure 5 is the same as figure 4 with the addition
20 of a frequency crossover circuit hookup.

21

22 Figure 6 is a circuit diagram including components
23 for a passive crossover and lumped elements for the trace
24 runs of the structure shown in figure 5.

25

26

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29 **DETAILED DESCRIPTION OF THE DRAWINGS**

30

31 Referring to figure 1, a typical planar line source
32 stereo speaker system is shown where 1 is the planar line
33 source speaker and 2 is a conventional point source
34 speaker used to enhance the low frequency response only.

1 In this figure, there are two sets L and R of transducers
2 1 and 2 in order to reproduce stereo audio. The length of
3 the typical planar speaker 1 is typically from 40 inches
4 to 75 inches tall and the sound aperture may only be on
5 the order of 1 to 2 inches in order to best approximate a
6 true acoustical line source. There is no limitation on
7 the size or dimensions of the transducers.

8

9 Referring to figure 2, an end view of a typical
10 planar speaker is shown. The magnet structure 3 is set
11 up as sets of north/south magnet pairs 30 and 31, 32 and
12 33, 34 and 35 repelling each other from the top to the
13 bottom magnet and also with alternating polarity in the
14 dimension along the stretched film 5. The framework 4
15 holds the magnets in place and also holds and stretches
16 the film 5 on all four sides. The framework 4 can also
17 hold the film 5 on only two sides in some applications.
18 The magnets of magnet structure 3 are generally of a bar
19 shape and can be composed of Ceramics, Neodymium (a rare
20 earth) or other suitable magnetic materials.

21

22 Figure 3 is the planar film and structure for a
23 prior art planar film speaker. 5 is the film which
24 typically may be .3 millimeters thick and can be composed
25 of Mylar, Polyester, Kapton or other materials. 6 is the
26 electrical current carrying trace which is typically .3
27 millimeters thick and 3/16 inch wide and can vary in both
28 thickness and width depending on the impedance desired. 7
29 is the positive connection terminal for the electrical
30 current, and 8 is the negative connection terminal. The
31 trace run specifically shown in the figure is referred to
32 as a "six turn run" as the trace traverses the total
33 length of the film six times in one continuous run. This
34 prior art configuration has the drawback of producing

1 less acoustical energy in the higher frequency audible
2 range.

3
4 Figure 4 is one embodiment of the invention in which
5 there are two electrically separate trace runs
6 essentially occupying the same area of the film. In this
7 case, one continuous run transverses the length of the
8 film four times ("four run") and the other only two times
9 ("two run"). 13 is the four run trace and 14 is the two
10 run trace. 9 is the positive terminal for the two run
11 trace and 10 is the positive terminal for the two run
12 trace. 11 is the negative terminal for the four run trace
13 and 12 is the negative terminal for the two run trace.
14 Other trace run configurations of either multiple
15 independent circuits or different numbers of runs per
16 trace can also be implemented depending on the desired
17 results of impedance and frequency response.

18
19 Figure 5 is an embodiment of the invention including
20 a frequency selective network 15. 16 is the positive
21 input from the power amplifier, and 17 is the negative
22 input from the power amplifier. In figure 5, the current
23 from the power amplifier is applied directly to the four
24 run trace 13 but goes through the frequency selective
25 network before going through the two run trace 14.
26 Therefore, the full frequency spectrum on the amplifier
27 signal drives the four run circuit. The two run circuit
28 14, however, is driven through a frequency selective
29 network 15 which in one case only passes frequencies
30 above where the four run trace circuit begins to
31 naturally fall off or produce less acoustical energy. In
32 one application, the frequency selective network is a
33 passive (no external power is applied) high pass filter
34 which allows only the spectral energy above 5,000 to

1 6,000 Hz to be applied to the two run circuit. The
2 frequency shaping of the frequency selective network can
3 of course vary on both frequency and filter
4 characteristics in order to achieve the desired results
5 of impedance and acoustical frequency response.
6

7 Figure 6 is an embodiment of the passive high
8 frequency cross over network **15** along with a lumped
9 element representation of the two and four line trace
10 planar transducer. **19** is the lumped impedance of the four
11 line trace **13** and **18** is the lumped impedance of the two
12 line trace **14**. All component values can vary depending on
13 the type of filter characteristics and impedance's
14 desired, however, a typical value for the inductor **21** is
15 0.044 mHenry, and the typical value for the capacitor **20**
16 value is 10 or 12 uFarad. The filter topology will change
17 for other types of filters such as bandpass or lowpass.
18

19 In this embodiment, the frequency peaking at 5Khz to
20 6Khz of the single continuous prior art configuration is
21 eliminated in the four run circuit **13** by having the extra
22 frequency dependent impedance of the crossover circuit
23 become significant in the region where the frequency
24 peaking occurred. By driving the additional two run
25 circuit **14** with only the higher frequencies, overall
26 acoustic energy frequency flatness is achieved, and the
27 audio energy exhibits the line source output with both a
28 small aperture and constant radiation characteristics
29 over the desired spectral energy range.
30

31 Although the present invention has been described
32 with reference to preferred embodiments, numerous
33 modifications and variations can be made and still the
34 result will come within the scope of the invention. No

1 limitation with respect to the specific embodiments
2 disclosed herein is intended or should be inferred.
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I CLAIM:

1. A planar line source speaker comprising:
 - a magnet pair having a space between a first and a second member of the magnet pair;
 - a vibratable film mounted across the space;
 - a first line trace circuit mounted on the vibratable film; and
 - a second line trace circuit mounted adjacent to the first line trace circuit.
2. The apparatus of claim 1, wherein the first line trace circuit is a four run trace, and the second line trace circuit is a two run trace.
3. The apparatus of claim 2, wherein the first line trace circuit is rectangular, and the second line trace circuit is rectangular having a size to fit inside a boundary of the first line trace circuit.
4. The apparatus of claim 3, wherein the second line trace circuit further comprises a frequency selective network means functioning to only pass frequencies above where the first line trace circuit begins to naturally fall off.
5. The apparatus of claim 4, wherein the frequency selective network means further comprises a passive high pass filter which allows only a spectral energy above a range of about 5000 to 6000 Hz to be applied to the second line trace circuit.

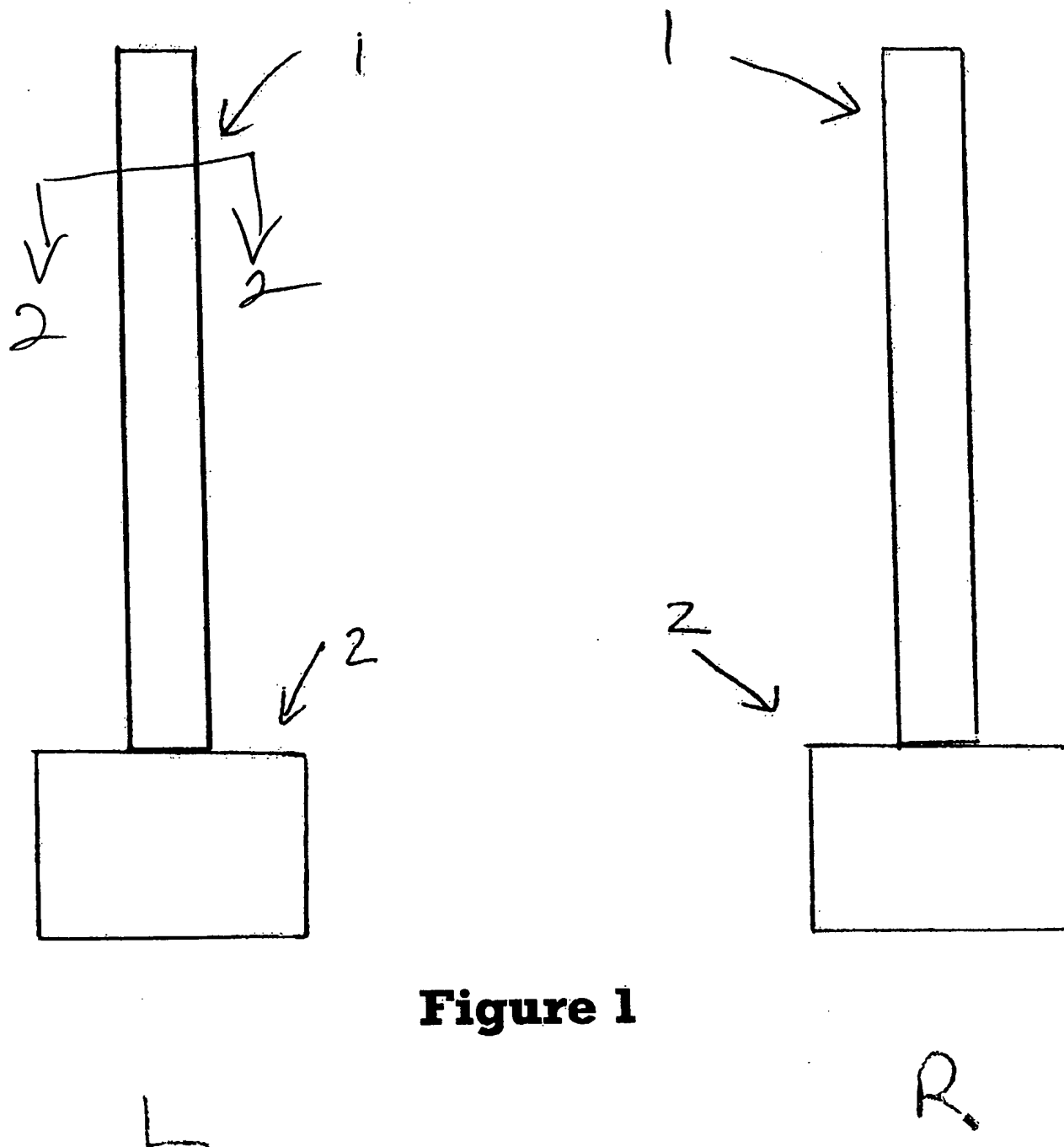


Figure 1

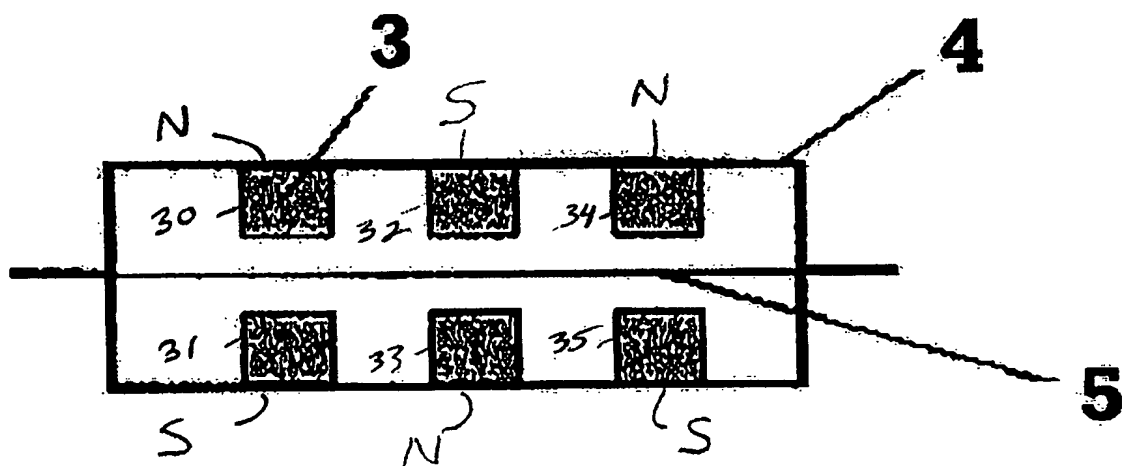


Figure 2

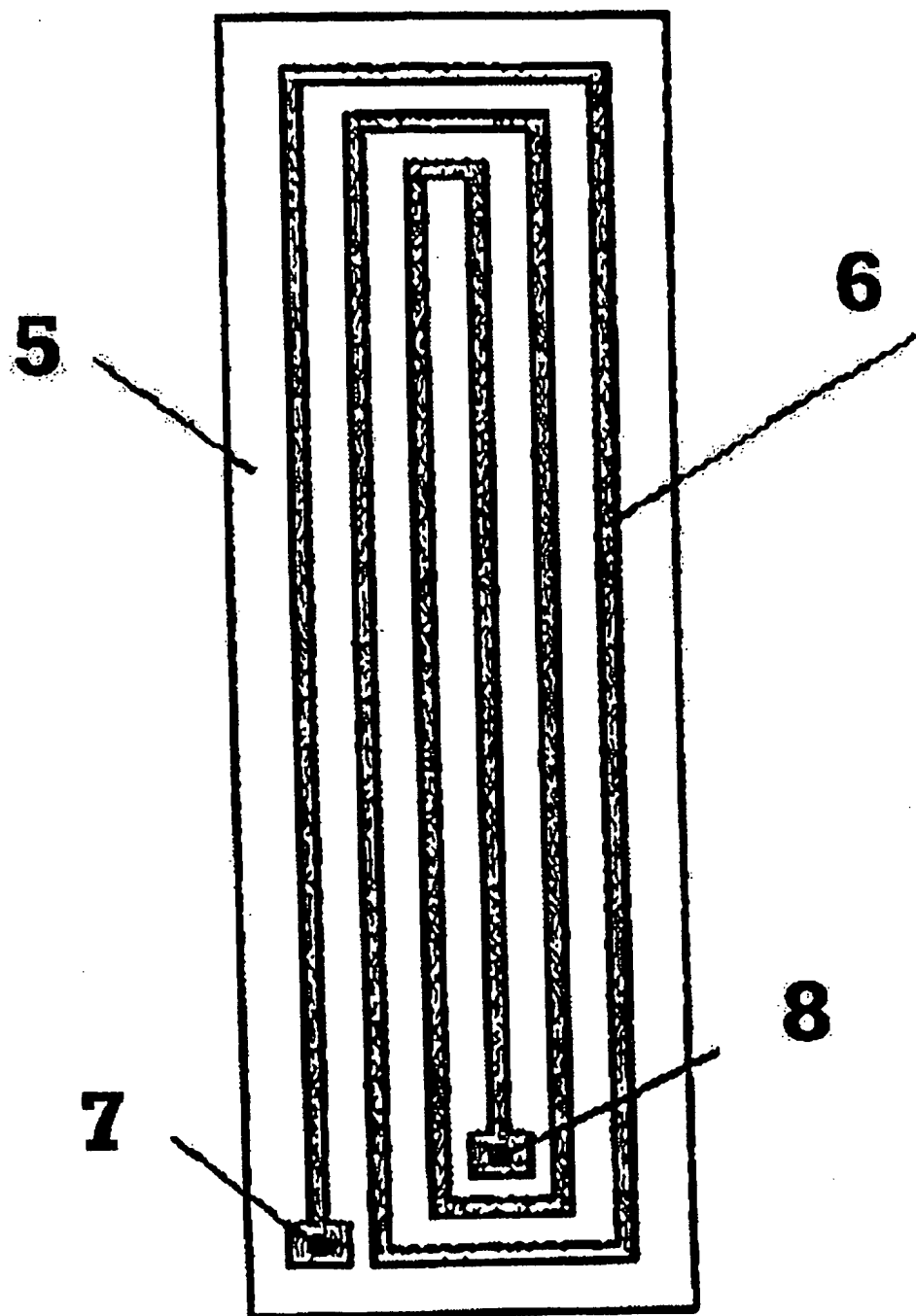


Figure 3
(PRIOR ART)

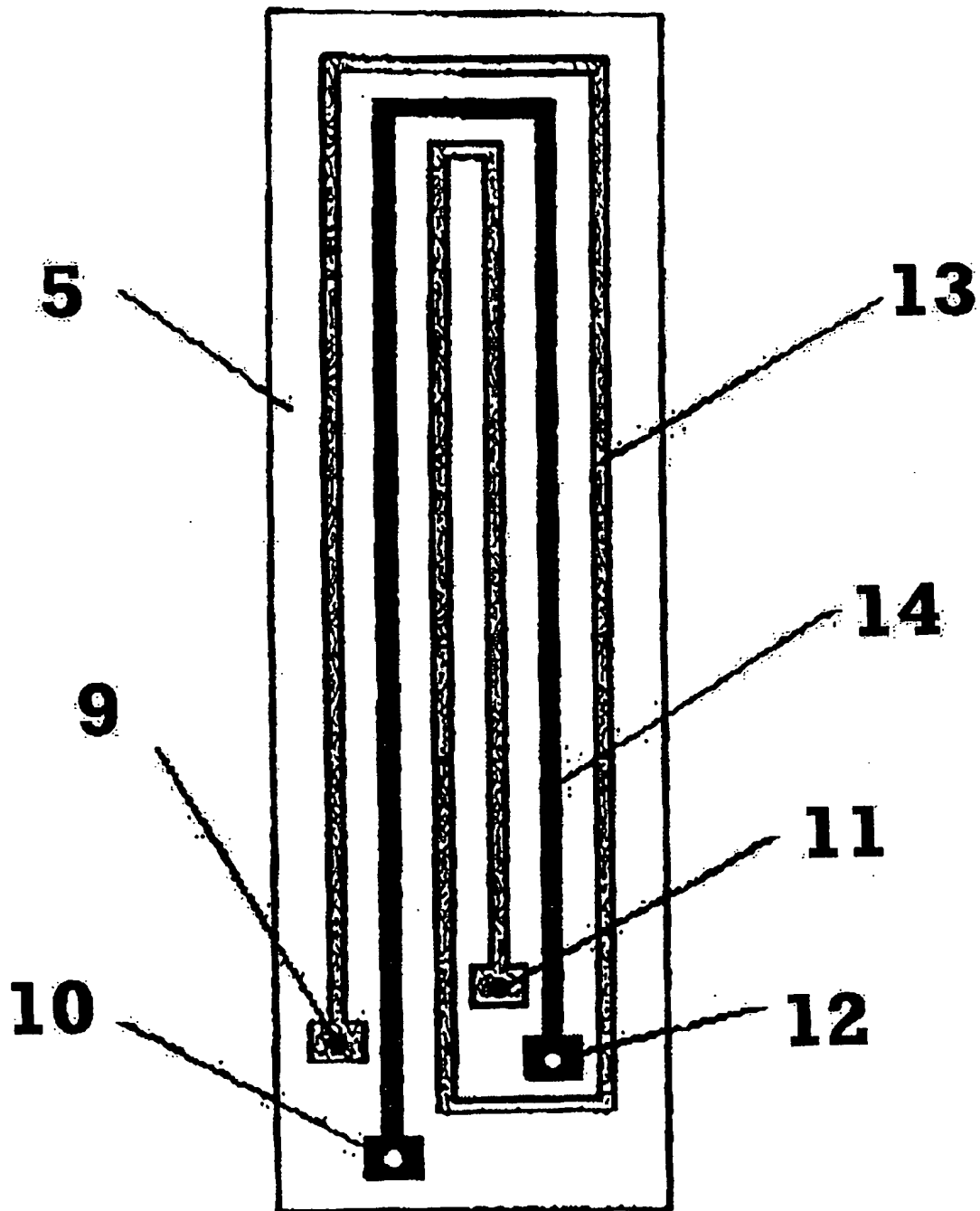
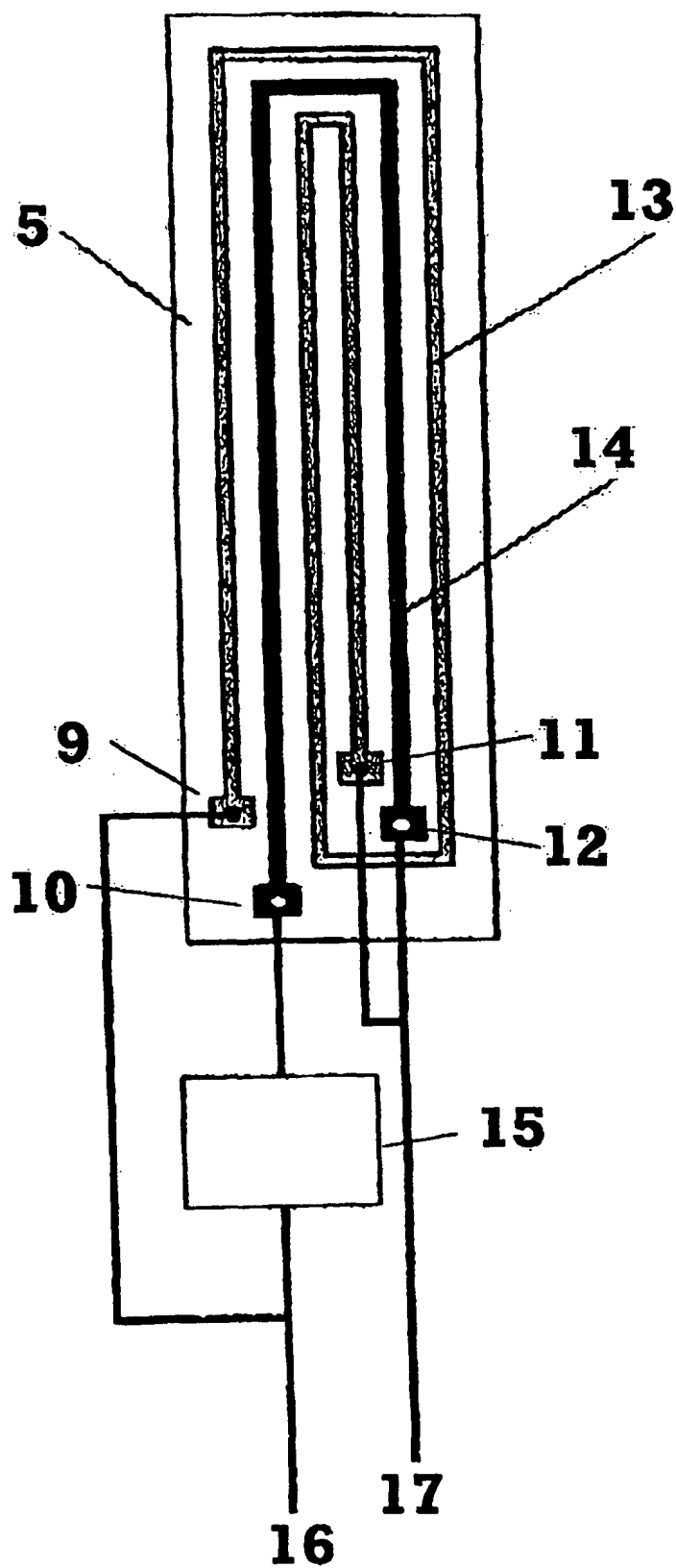


Figure 4

**Figure 5**

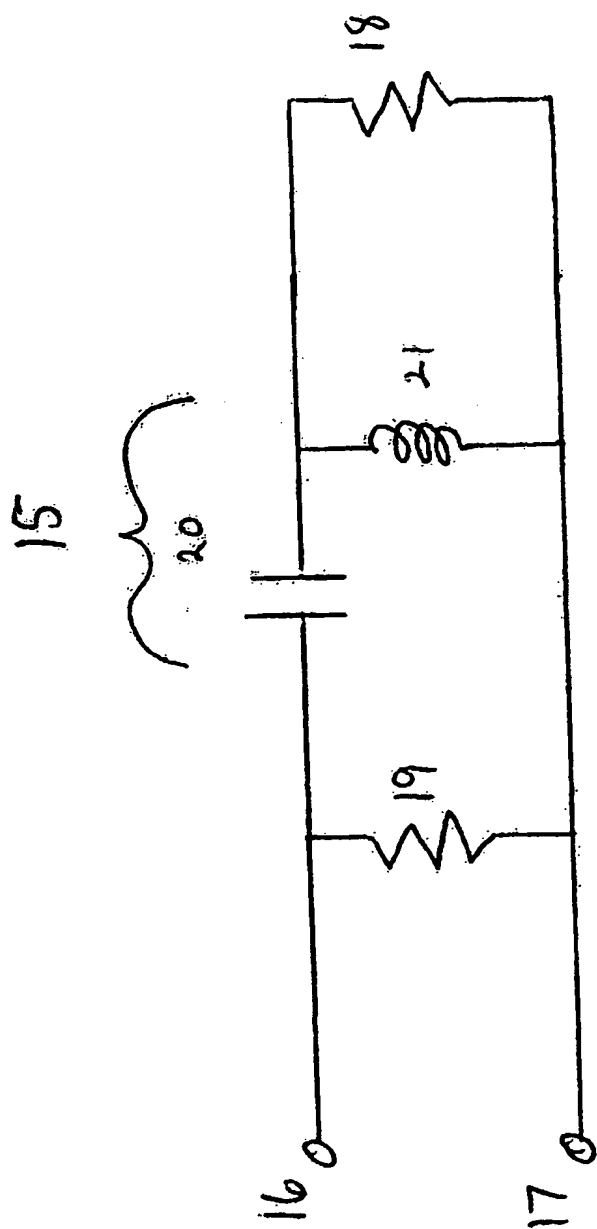


Figure 6

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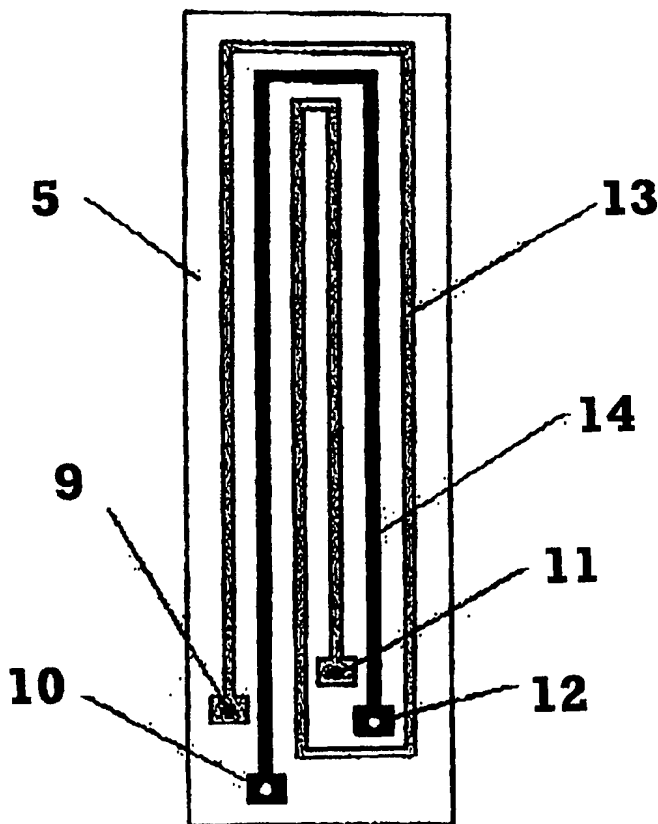
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[Continued on next page]

(54) Title: PLANAR SPEAKER WIRING LAYOUT



(57) Abstract: Trace runs for Planar Line Source Transducers (or speakers) are separated into multiple trace circuits which are electrically isolated but occupy the same area on the planar film. The separate trace runs are then driven with different electrical signals with tailored spectral content in order to achieve an overall acoustical frequency response. By having the separate trace runs occupy the same area, the line source nature of the transducer is preserved over the entire intended spectral response of the transducer and the mechanical structure is also kept simple. External spectral filtering circuits are used to pre-shape the spectral signal into each individual trace run and in most cases, the filtering components are passive and inexpensive.

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B. FIELDS SEARCHED

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IPC 7 H04R

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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Y	column 3, line 15 -column 4, line 41; figures	4,5
Y	--- US 3 919 499 A (WINEY JAMES M) 11 November 1975 (1975-11-11) cited in the application column 1, line 14 -column 2, line 61; figures	4,5
X	--- US 5 297 214 A (BRUNEY PAUL F) 22 March 1994 (1994-03-22) column 5, line 6 -column 6, line 9; figures	1
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☒ Further documents are listed in the continuation of box C.☒ Patent family members are listed in annex.

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Date of the actual completion of the international search

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INTERNATIONAL SEARCH REPORT

International Application No
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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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Form PCT/ISA/210 (continuation of second sheet) (July 1992)

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Information on patent family members

In International Application No

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